

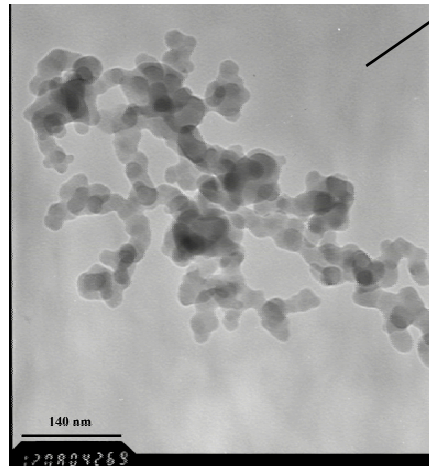
Porous Materials from Nanoparticle Agglomerates

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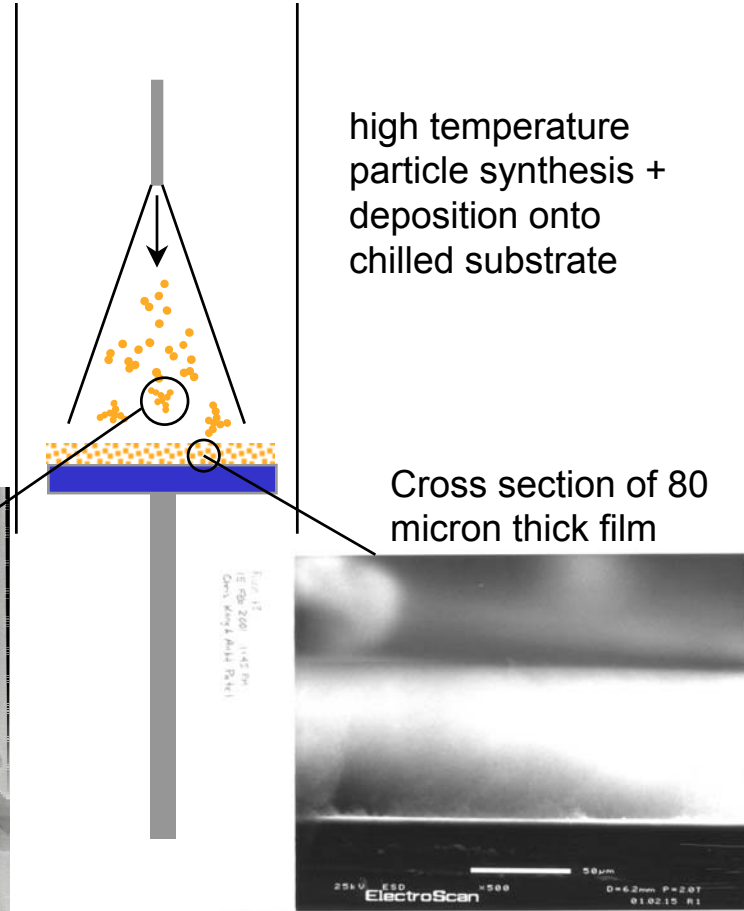
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- **Objective:** Develop a particle formation-deposition process to produce porous films from nanoparticles.
- **Accomplishments:**
 - Rapid growth of porous alumina films
 - Extension to titania films underway
 - Modeling of temperature and flow profiles in reactor



Nanoparticle agglomerates



Cross section of 80 micron thick film

The process we are developing is a novel approach to the generation of porous materials with applications towards photovoltaic materials, sensors, and catalytic materials among others. In the figure, a transmission electron micrograph of an alumina nanoparticle agglomerate is shown on the left hand side. These particles form from reaction of aluminum acetylacetonate vapor, and subsequent gas-to-particle conversion and growth. The agglomerates have a necked structure. The image on the right hand side shows a cross section of an 80 micron thick porous film, made by deposition of these agglomerates via thermophoresis onto a water cooled stage. The reactor temperatures can be varied from 800 to 1100 °C, and the stage temperature ranges from 30 to 120 °C. Film growth rates are fast, on the order of a micron/per minute, using this technique. Because the substrate is kept at low temperatures, this will enable deposition onto polymeric membranes and other materials with low thermal stability. We are in the process of extending this to the formation of titania films. We are also studying the deposition uniformity, both experimentally and theoretically using a model of particle deposition, and we are pursuing a strategy for strengthening the films via capillary condensation. This project involves work that overlaps the disciplines of chemical engineering and materials science. We are developing a thorough understanding of this process and this will contribute to the design of similar processes in the future. It is anticipated that this process could be scaled up by industry for commercial production of a variety of materials.

A course in Particle Science and Technology was taught by the PI for the first time during the Spring 2002 semester incorporating current topics in aerosol processing of materials as well as in theories of particle formation and growth. Outreach activities have consisted of visits by the PI to a high school in Washington DC, Bell Multicultural High School, and visits by interested high school students from Bell to the University of Maryland.